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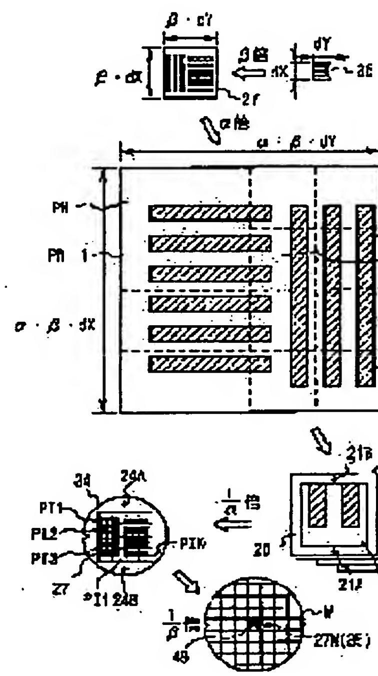
(54) PRODUCTION OF MASK

(57)Abstract:

PROBLEM TO BE SOLVED: To form a transfer pattern with high accuracy in a short time by using a second substrate from which a part of an absorbing layer is removed as a reflection type mask.

SOLUTION: In the first step, a master pattern 36 is formed by magnifying the pattern to be formed on a mask, and the master pattern 36 is drawn on a first substrate which transmits UV rays in 100 to 400 nm wavelength region to produce master masks P1 to PN. In the second step, a reflection layer which reflects ultra UV rays and an absorbing layer which absorbs the ultra UV rays are formed on a specified second substrate. In the third step, reduced images of the patterns of the master masks P1 to PN are projected on the second substrate by using a reduction stepper which reduces and projects an image with UV rays of 100 to 400 nm wavelength as exposure beams so as to remove a part of the absorbing layer. The second substrate from which a part of the absorbing layer is removed is used as a reflection type mask.



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CLAIMS

[Claim(s)]
[Claim 1] It is the manufacture approach of the mask of the reflective mold for aligners using the extreme ultraviolet radiation of the range whose wavelength is 1-50nm as an exposure beam. the 1st original edition pattern which expanded the pattern formed in said mask -- creating -- this -- with the 1st process which draws on the 1st substrate which makes the ultraviolet radiation whose wavelength is 100-400nm about the 1st original edition pattern penetrate, and manufactures a parent mask The 2nd process which carries out the laminating of the reflecting layer which reflects said extreme ultraviolet radiation, and the absorption layer which absorbs said extreme ultraviolet radiation, and forms it on the 2nd predetermined substrate, Projection exposure of the contraction image of the pattern of said parent mask with which wavelength was manufactured at said 1st process using the projection aligner which performs contraction projection by using as an exposure beam ultraviolet radiation which is 100-400nm is carried out on the 2nd [said] substrate manufactured at said 2nd process. The manufacture approach of the mask characterized by using said 2nd substrate from which it has the 3rd process which removes said a part of absorption layer, and said a part of absorption layer was removed as said reflective type of a mask.
[Claim 2] Said 2nd substrate is the manufacture approach of the mask according to claim 1 characterized by being a circular substrate substantially.
[Claim 3] Claim 1 characterized by said 2nd substrate moving in one the attachment component by which adsorption maintenance is carried out, and this 2nd substrate in the projection aligner used at said 3rd process, or the manufacture approach of a mask given in two.
[Claim 4] Claims 1 and 2 characterized by holding this substrate in the projection aligner used at said 3rd process so that the front face of said 2nd substrate may maintain the flatness of 0.1-0.3 micrometers substantially on 100mm square, or the manufacture approach of a mask given in three.

[Translation done.]

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] In case this invention manufactures the mask for aligners which uses especially extreme ultraviolet radiation (EUV light), such as soft X ray, as an exposure beam about the manufacture approach of the mask used as an original edition pattern in case micro devices, such as a semiconductor integrated circuit, image sensors (CCD etc.), a liquid crystal display component, or the thin film magnetic head, are manufactured using a lithography technique, it is used, and it is suitable.
[0002]
[Description of the Prior Art] In case devices, such as a semiconductor integrated circuit, are manufactured, the photo mask with which the original edition pattern which expanded the circuit pattern which should be formed to about 4 to 5 times was formed is used, and the imprint method which carries out contraction projection of the pattern of this photo mask on exposed substrates, such as a wafer or a glass plate, through contraction projection optics is used. An aligner is used in the case of the imprint of the pattern of such a photo mask, and the photo mask used with the contraction projection mold aligner of a step-and-repeat method is also called the reticle.
[0003] Conventionally, such a reticle was manufactured by using an electron beam exposure system or laser beam drawing equipment on a predetermined substrate (BURANKUSU), and drawing an original edition pattern. That is, after forming a mask ingredient (light-shielding film) and applying a resist on the substrate, the original edition pattern is drawn using an electron beam exposure system or laser beam drawing equipment. Then, the original edition pattern was formed with the mask ingredient by developing the resist and performing etching processing etc. in this case, since the pattern which expanded the pattern of a device beta twice is sufficient as the original edition pattern drawn by that reticle when the contraction scale factor of the aligner of the contraction projection mold which uses that reticle is made into 1/beta twice, the drawing error by drawing equipment is reduced about 1/beta twice on a device. therefore, the pattern of a device can be substantially formed by twice [about 1/beta] as many resolving power as the resolving power by drawing equipment.
[0004]
[Problem(s) to be Solved by the Invention] Conventionally, the original edition pattern of a reticle was drawn by the electron beam exposure system or laser beam drawing equipment like the above. About this, according to the advance of a lithography technique, the minimum line width (resolution) of the projection image for which an aligner is asked is becoming thin gradually, and it is predicted in 2005 that it is necessary to expose the pattern of the minimum line width not more than about 100nm or it. The contraction projection mold exposure approach (b) optical [as the exposure approach for exposing such a pattern], A contraction imprint (**) -- the contraction imprint and ion beam (Ha) using an electron ray were used -- The exposure approach of a pro squeak tee method of having used the (d) X-ray, The lithography technique (EUVL:Extreme Ultraviolet Lithography) which projects the contraction image of the reticle of a reflective mold by using as an exposure beam extreme ultraviolet radiation (EUV light) which consists of soft X ray with a wavelength of about 5-20nm is examined. and (**) -- As for the part, development is actually performed. The especially leading exposure approach in these is EUVL of (e).
[0005] Moreover, the point that all except the exposure approach of a pro squeak tee method that the

X-ray of (d) was used for these exposure approaches are the projection exposure approaches which made the contraction scale factor about 1 / four to 1/10 is common. So, in order to expose on a wafer the pattern whose minimum line width is about 100nm, using a contraction scale factor as 1/4 time, on a corresponding reticle, minimum line width needs to form the original edition pattern which is about 400nm. In this case, if control precision of required line breadth is made into about **5% of minimum line width, the line breadth control precision of about **20nm or less will be required.
[0006] Furthermore, since the superposition precision (overlay accuracy) for which an aligner is asked is about [of minimum line width] 1/3, the superposition precision for which minimum line width is needed with the aligner which is about 100nm is set to about 30nm or less. The location precision from which the alignment precision of the stage system of an aligner, the distortion of a contraction projection system, etc. are permitted by the original edition pattern of a reticle itself besides the location precision of the original edition pattern on a reticle by the factor which determines superposition precision for a certain reason is about at most 10nm.
[0007] As mentioned above, if the minimum line width on a wafer becomes about [of about 100nm, i.e., current minimum line width,] 1/2, the degree of integration of the original edition pattern on a corresponding reticle will increase about 4 times. The drawing time amount of the original edition pattern whose electron beam exposure system (the same is said of laser beam drawing equipment) is a picture-drawn-without-lifting-the-brush-from-the-paper method so to speak at this time and that minimum line width of whose is about 100nm since drawing (being in inverse proportion to square of minimum line width) time amount becomes long in proportion [almost] to the degree of integration of an original edition pattern increases by about 4 times the present drawing time amount. However, it continued between such long drawing time amount (for example, half a day - one day), and it is difficult to maintain the drawing equipment at a stable condition, and there was a possibility that the location gap which exceeds the allowed value of an original edition pattern in the drawing time amount might arise. Furthermore, when manufacturing two or more sheets of the reticle (working reticle), for example to two or more production lines, the time amount which manufacture takes in proportion to the number of sheets will become long.
[0008] Moreover, using the silicon wafer itself is examined as a substrate of the reticle of the reflective mold for EUVL. The about about 5 times, since it is large, if, as for the coefficient of linear expansion of a silicon wafer, the drawing time amount by the electron beam exposure system becomes long to a thing with a small coefficient of linear expansion, it becomes impossible however, for the quartz currently generally used conventionally to also disregard a location gap of the original edition pattern by the thermal expansion of the silicon wafer in the drawing time amount.
[0009] Furthermore, it is not necessarily easy in the present condition to suppress the location precision of an original edition pattern to about 10nm as mentioned above with an electron beam exposure system, either. It sets it as the 1st purpose that this invention offers the manufacture approach of the mask which can form the pattern for an imprint in a short time with high precision in view of this point. Moreover, this invention sets it as the 2nd purpose to offer the manufacture approach of the mask which can form the mask which can use extreme ultraviolet radiation (EUV light) as a mask of a reflective mold in the aligner used as an exposure beam with high precision in a short time.
[0010]
[Means for Solving the Problem] The manufacture approach of the mask by this invention is the manufacture approach of the mask (34) of the reflective mold for aligners using the extreme ultraviolet radiation (EUV light) of the range whose wavelength is 1-50nm as an exposure beam. The 1st original edition pattern (36) which expanded the pattern formed in the mask is created. The 1st process which draws on the 1st substrate which makes the ultraviolet radiation whose wavelength is 100-400nm about this 1st original edition pattern penetrate, and manufactures a parent mask (P1, P2, --, PN), The 2nd process which carries out the laminating of the reflecting layer (31) which reflects the extreme ultraviolet radiation, and the absorption layer (32) which absorbs the extreme ultraviolet radiation, and forms it on the 2nd predetermined substrate (4), The projection aligner which performs contraction projection by using as an exposure beam ultraviolet radiation whose wavelength is 100-400nm is used. Projection exposure of the contraction image of the pattern of the parent mask (P1, P2, --, PN) manufactured at the 1st process is carried out on the 2nd substrate (4) manufactured at the

2nd process. It has the 3rd process which removes a part of the absorption layer (32), and the 2nd substrate (4) from which a part of the absorption layer was removed is used as the reflective type of a mask.
[0011] In case according to this this invention an electron beam exposure system is used in case the 1st original edition pattern is drawn on the 1st substrate, and the contraction image of the 1st original edition pattern is projected on the 2nd substrate, the projection aligner which makes exposure light excimer laser light, such as KrF (wavelength of 248nm) or ArF (wavelength of 193nm), and ultraviolet radiation the outside of it, i.e., an optical projection aligner, is used. the 1st original edition pattern is a pattern which expanded the pattern of the mask finally manufactured alpha twice, and since the effect of the drawing error of an electron beam exposure system is reduced by 1/alpha, the pattern (pattern for an imprint) of the mask is formed with high precision. And in order for what is necessary to be just to imprint the 1st original edition pattern with the optical projection aligner in manufacturing the two or more masks, the time amount which manufacture of the mask takes is shortened sharply.
[0012] Moreover, the reflecting layer (31) of the reflective type of mask is formed by carrying out the laminating of the thin film of two kinds of matter more than the number of predetermined groups by turns, and the absorption layer (32) is formed from the thin film of one kind of matter. Then, the pattern of the mask of a reflective mold is formed with high precision by removing a part of absorption layer (32) on a reflecting layer (31). Moreover, since the usual semi-conductor aligner can be used for the optical projection aligner almost as it is by using the substrate of the reflective type of mask as substrates, such as for example, a semi-conductor wafer, a manufacturing cost can be reduced.
[0013]
[Embodiment of the Invention] Hereafter, with reference to a drawing, it explains per example of the gestalt of operation of this invention. Drawing 1 shows the production process of the reticle as a mask of this example, and the reticle made applicable to manufacture by this example in this drawing 1 is the working reticle 34 of the reflective mold used in case a semiconductor device is manufactured. this working reticle 34 consists of wafers (wafer), such as a silicon wafer, -- substantially, the reflective film and an absorption layer are used for the whole surface of a thin circular substrate, and the original edition pattern 27 is formed. Moreover, two alignment marks 24A and 24B are formed so that the original edition pattern 27 may be inserted. In addition, as an ingredient of the substrate, low thermal expansion glass, a quartz, a metal, etc. can be used.
[0014] furthermore, the working reticle 34 is used through the projection optics of the projection aligner which made exposure light extreme ultraviolet radiation (EUV light) of an about 1-50nm soft-X-ray region by contraction projection of 1 / beta twice (beta is a larger integer than 1 or a half-integer, and is 4, 5, or 6 grades as an example). that is, in drawing 1 , after exposing to each shot field 48 on the wafer W with which contraction image 27W 1 / twice [beta] as many as the original edition pattern 27 of the working reticle 34 were applied to the resist, the predetermined circuit pattern 35 is formed in each of that shot field 48 by performing development, etching, etc. Hereafter, it explains per example of the production process of the working reticle 34 of this example.
[0015] In drawing 1 , the circuit pattern 35 of a certain layer of the semiconductor device finally manufactured first is designed. The circuit pattern 35 forms Rhine [of the versatility / width of face / of the side which intersects perpendicularly / in the field of the rectangle of dX and dY] -, - tooth-space pattern, etc. in this example, the original edition pattern 27 with which the circuit pattern 35 is expanded beta twice, and the width of face of the side which intersects perpendicularly consists of a field of the rectangle of beta-dX and beta-dY is created on the design data (image data is included) of a computer. beta twice are the inverse number of the contraction scale factor (1/beta) of the projection aligner with which the working reticle 34 is used.
[0016] It carries out. next, the original edition pattern 27 -- alpha twice (alpha is a larger integer than 1 or a half-integer, and is 4, 5, or 6 grades as an example) -- Create the parent pattern 36 with which the width of face of the side which intersects perpendicularly consists of a field of the rectangle of alpha-beta-dX and alpha-beta-dY on a design data (image data is included), and the parent pattern 36 is divided into alpha individual in all directions, respectively. The parent patterns P1, P2, P3, --, PN (N=alpha 2) of an alphaxalpha individual are created on a design data. The case of alpha= 4 is shown

by drawing 1 . In addition, the need of making the scale factor alpha from the original edition pattern 27 to the parent pattern 36 not necessarily agreeing does not have the number of partitions alpha of this parent pattern 36. Then, from those parent patterns Pi (i= 1 - N), the drawing data for electron beam exposure systems (or laser beam drawing equipment etc. can be used) are generated, respectively, and the parent pattern Pi is imprinted on the master reticle Ri as a parent mask by actual size, respectively.
[0017] for example, in case the master reticle R1 of the 1st sheet is manufactured On the substrate (it corresponds to the 1st substrate of this invention) of light transmission nature, such as quartz glass, quartz glass which mixed the fluorine, or fluorite, chromium (Cr), or silicification -- after forming the thin film of mask ingredients, such as molybdenum ($MoSi_2$ etc.), and applying an electron beam resist on this, the actual size image of the 1st parent pattern P1 is drawn on that electron beam resist using an electron beam exposure system. Then, after developing an electron beam resist, the parent pattern P1 is formed in the pattern space 20 on the master reticle R1 by performing etching, resist exfoliation, etc. In this case, on the master reticle R1, the alignment marks 21A and 21B which consist of two two-dimensional marks by position relation to the parent pattern P1 are formed. Similarly, an electron beam exposure system etc. is used for other master reticles Ri, and the parent pattern Pi and the alignment marks 21A and 21B are formed in them, respectively. It is used for the alignment at the time of these alignment marks 21A and 21B performing a screen splice behind.
[0018] thus, the case where the amount of each drawing data carries out direct writing of the original edition pattern 27 in this example since each parent pattern Pi which draws with an electron beam exposure system (or laser beam drawing equipment) is a pattern which expanded the original edition pattern 27 alpha twice -- comparing -- 1/alpha 2 It is decreasing to extent. since [furthermore,] it is twice [alpha] (for example, 5 times or 4 times) the minimum line width of the parent pattern Pi of this compared with the minimum line width of the original edition pattern 27 -- the electron beam resist of the former [pattern / Pi / each / parent] respectively -- using -- an electron beam exposure system -- a short time -- and it can draw with high precision. Moreover, since each parent pattern Pi is behind reduced and projected on 1/alpha, the drawing error of an electron beam exposure system is also substantially reduced to 1/alpha. Moreover, since the working reticle 34 of required number of sheets can be manufactured by repeating and using them like the after-mentioned once it manufactures the master reticles R1-RN of N sheets, the time amount for manufacturing the master reticles R1-RN is not a big burden.
[0019] next, the working reticle 34 is manufactured by imprinting the twice [1/alpha] as many contraction image PIi (i= 1 - N) as the parent pattern Pi of the above-mentioned master reticle Ri of N sheets, performing a screen splice, respectively. Therefore, as first shown in drawing 2 (A), as a substrate for working reticle 34, a diameter prepares the substrate 4 (it corresponds to the 2nd substrate of this invention) of the silicon wafer whose thickness is about 1mm by about 300mm, and carries out the laminating of the multilayer reflective film 31 on a substrate 4. As shown in drawing 2 (B) which expanded the B section of drawing 2 (A), the reflective film 31 is a pitch d2 (= 2, d1), and carries out the 50-set laminating of thin film 31a of the molybdenum (Mo) of thickness d1, and the thin film 31b of the silicon (Si) of thickness d1. Thickness d1 is 3.25nm as an example, and the thickness of 6.5nm and the whole reflective film 31 is set to about 325nm (0.325 micrometers) by the pitch d2 at this time. Thus, since the reflective film 31 which carried out the laminating of thin film 31a of molybdenum and the thin film 31b of silicon reflects extreme ultraviolet radiation (EUV light) with a wavelength of 13nm, the wavelength of the EUV light for working reticle 34 of this example is 13nm. In addition, what is necessary is to carry out the laminating of the thin film of molybdenum, and the thin film of beryllium (Be) by turns, and just to form the reflective film 31, when wavelength uses the EUV light which is 11nm.
[0020] Next, as shown in drawing 2 (C), the absorption layer 32 which consists of nickel (nickel) for absorbing EUV light is formed by about 1 micrometer in thickness on the reflective film 31 on a substrate 4. In this case, an alignment mark may be formed if needed. Furthermore, the photoresist layer 33 exposed on the absorption layer 32 at light with a wavelength of 248nm is applied to the thickness of about 1 micrometer. In addition, other metals etc. may be used as an ingredient of the absorption layer 32. Then, as shown in drawing 2 (D), exposure of the pattern image of a master reticle is performed to the photoresist layer 33 on the substrate 4, performing a screen splice using

the exposure light IL.
[0021] Drawing 3 shows the optical contraction projection mold aligner used in case it exposes to that substrate 4, and the exposure light IL is irradiated in this drawing 3 by the reticle on a reticle stage 2 from the illumination-light study system 1 which consists of a fly eye lens, an illumination system aperture diaphragm, a reticle blind (adjustable field diaphragm), a condensing lens system, etc. for the exposure light source and illuminance distribution equalization at the time of exposure. On the reticle stage 2 of this example, the i-th master reticle (i= 1 - N) Ri is laid. In addition, as an exposure light, although KrF excimer laser light (wavelength of 248nm) is used in this example, it is ArF excimer laser light (wavelength of 193nm), and F2 in addition to it. Wavelength can use the ultraviolet radiation which is about 100-400nm like a laser beam (wavelength of 157nm), the higher harmonic of solid state laser, or i line (wavelength of 365nm) of a mercury lamp.
[0022] The image of the pattern in the lighting field of the master reticle Ri is projected on the photoresist layer of the front face of a substrate 4 through projection optics 3 for 1/(1/alpha is 1/4 at this example) of contraction scale factors alpha. The numerical aperture of projection optics 3 is about 0.7, and resolution is about 200nm. Although the projection optics 3 of this example is the refractive media of a both-sides tele cent rucksack, the reflective refractive media which contain a concave mirror etc. in addition to it may be used for it. The Z-axis is taken in parallel with the optical axis AX of projection optics 3 hereafter, in a flat surface perpendicular to the Z-axis, in parallel with the space of drawing 3 , at right angles to the space of drawing 3 , a Y-axis is taken and the X-axis is explained.
[0023] First, a reticle stage 2 positions the master reticle Ri on this in XY flat surface. The location of a reticle stage 2 is measured by the non-illustrated laser interferometer, and actuation of a reticle stage 2 is controlled by this measurement value and control information from the main control system 9. On the other hand, a substrate 4 is held by electrostatic adsorption on the disc-like substrate holder 22 as an attachment component, this substrate holder 22 is fixed on the sample base 5, and the sample base 5 is being fixed on X-Y stage 6. The sample base 5 doubles the front face of a substrate 4 with the image surface of projection optics 3 by controlling the focal location (location of the optical-axis AX direction) of a substrate 4, and a tilt angle by the automatic focus method. Moreover, X-Y stage 6 positions the sample base 5 (substrate 4) in the direction of X, and the direction of Y with a linear motor system on the base 7.
[0024] this example -- a substrate 4 and the substrate holder 22 -- the sample base 5 -- receiving -- one ---like -- for example, electromagnetism -- it is detached and attached by the adsorption method. And a substrate 4 and the substrate holder 22 are detached [also in case the aligner which uses EUV light as a working reticle 34 behind is equipped with a substrate 4] and attached in one to the aligner. It is prevented that a foreign matter mixes between a substrate 4 and the substrate holder 22 in down stream processing of a substrate 4, and the flatness of a substrate 4 gets worse by this. Furthermore, the front face of the substrate holder 22 is finished so that it may become the flatness of about 0.1-0.3 micrometers or less on 100mm square as an example. A substrate 4 is in the condition which maintained very high flatness, and is held on the substrate holder 22 by this. In addition, substrate holder 22A of the vacuum adsorption method currently fixed to the sample base 5 may be used instead of the substrate holder 22.
[0025] Moreover, by 8m of migration mirrors fixed to the upper part of the sample base 5, and the laser interferometer 8 countered and arranged, the X coordinate of the sample base 5, Y coordinate, and an angle of rotation are measured, and this measurement value is supplied to the stage control system 10 and the main control system 9. 8m of migration mirrors represents migration mirror 8mX of the X-axis, and migration mirror 8mY of a Y-axis, as shown in drawing 4 . A stage control system 10 controls actuation of the linear motor of X-Y stage 6 etc. based on the measurement value and the control information from the main control system 9.
[0026] Moreover, in this example, the ledged reticle library 16 is arranged in the side of a reticle stage 2, and the master reticles R1, R2, --, RN are laid on the support plate 17 of N individual by which the sequential array was carried out into the reticle library 16 at the Z direction. These master reticles R1-RN are reticles (parent mask) in which the parent patterns P1-PN which divided the parent pattern 36 of drawing 1 , respectively were formed. The reticle library 16 is supported free [migration to a Z direction] by slide equipment 18, and the reticle loader 19 equipped with the arm

which can rotate freely between a reticle stage 2 and the reticle library 16, and can move to it in the predetermined range at a Z direction is arranged. After the main control system 9 adjusts the location of the Z direction of the reticle library 16 through slide equipment 18, actuation of a reticle loader 19 is controlled, and it is constituted so that the desired master reticles R1-RN can be delivered between the support plate 17 of the request in the reticle library 16, and a reticle stage 2.
[0027] Moreover, the stores 11, such as a magnetic disk drive, are connected to the main control system 9, and the exposure data file is stored in the store 11. The mutual physical relationship of the master reticles R1-RN, the data of alignment information, etc. are recorded on the exposure data file. After exposure of the contraction image of the 1st master reticle R1 to the 1st shot field on a substrate 4 is completed at the time of the exposure to the substrate 4 of this example, the next shot field on a substrate 4 moves to the exposure field of projection optics 3 by step migration of X-Y stage 6. In parallel to this, the master reticle R1 on a reticle stage 2 is returned to the reticle library 16 through a reticle loader 19, and the master reticle R2 for [of a degree] an imprint is laid on a reticle stage 2 through a reticle loader 19 from the reticle library 16. And after alignment is performed, projection exposure of the contraction image of the master reticle R2 is carried out to the shot field concerned on a substrate 4 through projection optics 3, and exposure of the contraction image of the master reticles R2-RN which carries out sequential correspondence to the remaining shot fields on a substrate 4 by the step-and-repeat method below is performed.
[0028] In addition, although the projection aligner of drawing 2 is an one-shot exposure mold instead, the contraction projection mold aligner (scanning aligner) of a scan exposure mold like step - and - scanning method may be used. In a scan exposure mold, the synchronous scan of a master reticle and the substrate 4 is carried out by the contraction scale-factor ratio to projection optics 3 at the time of exposure. By using an optical scanning aligner, the effect of the distortion of projection optics etc. is mitigable.
[0029] Now, in case the contraction image of the master reticles R1-RN is exposed on a substrate 4 in this way, it is necessary to perform the screen splice between adjoining contraction images (connecting) with high precision. For that, it is necessary to perform alignment of each master reticle Ri (i= 1 - N) and the shot field (referred to as Si) where it corresponds on a substrate 4 with high precision. The projection aligner of this example is equipped with the reticle and the alignment device for substrates for this alignment.
[0030] Drawing 4 is the perspective view showing the important section of the projection aligner of drawing 3 , in this drawing 4 , the reference mark member 12 of light transmission nature is fixed near the substrate 4 on the sample base 5, and one pair of reference marks 13A and 13B of a cross-joint mold are formed at intervals of predetermined in the direction of X on the reference mark member 12. Moreover, the illumination system which illuminates reference marks 13A and 13B is installed in the projection optics 3 side by the pars basilaris ossis occipitalis of reference marks 13A and 13B by the illumination light which branched from the exposure light IL. At the time of the alignment of the master reticle Ri, by driving X-Y stage 6 of drawing 3 , reference marks 13A and 13B are positioned so that the core of the reference marks 13A and 13B on the reference mark member 12 may agree in the optical axis AX of projection optics 13 mostly.
[0031] Moreover, two alignment marks 21A and 21B of a cross-joint mold are formed as an example so that the pattern space 20 of the pattern side (inferior surface of tongue) of the master reticle Ri may be inserted in the direction of X. It is in the condition of spacing of reference marks 13A and 13B being set up almost equally to spacing of the contraction image by the projection optics 3 of the alignment marks 21A and 21B, and having made the core of reference marks 13A and 13B agreeing in an optical axis AX mostly. By illuminating by the illumination light of the same wavelength as the exposure light IL from the base side of the reference mark member 12, the expansion image by the projection optics 3 of reference marks 13A and 13B is formed near the alignment marks 21A and 21B, respectively.
[0032] The mirror for reflecting the illumination light from a projection optics 3 side in the **X direction above these alignment marks 21A and 21B is arranged, and it has the alignment sensors 14A and 14B of an image pick-up method by the TTR (through THE reticle) method so that the illumination light reflected by these mirrors may be received. By the alignment sensors 14A and 14B, the image of the alignment marks 21A and 21B and the corresponding reference marks 13A

and 13B is picturized, and the image pick-up signal is supplied to the alignment signal-processing system 15 of drawing 3 .

[0033] The alignment signal-processing system 15 carries out the image processing of the image pick-up signal, calculates the amount of location gaps to the direction of X of the alignment marks 21A and 21B to the image of reference marks 13A and 13B, and the direction of Y, and supplies these 2 sets of amounts of location gaps to the main control system 9. The main control system 37 positions a reticle stage 2 so that 2 sets of the amounts of location gaps may fall within a predetermined range mutually symmetrically and, respectively. The parent pattern Pi (refer to drawing 1) of the alignment marks 21A and 21B, as a result the master reticle Ri is positioned to reference marks 13A and 13B by this.

[0034] In this condition, the main control system 9 of drawing 2 is memorizing the coordinate of the direction of X of the sample base 5 measured by the laser interferometer 8, and the direction of Y, and the alignment of the master reticle Ri ends it. After this, focusing on exposure of the parent pattern Pi, the point of the arbitration on the sample base 5 (substrate 4) is movable. Moreover, in drawing 4 , in order to perform location detection of the mark on a substrate 4, by the off-axis method, the side face of projection optics PL is equipped also with the alignment sensor (un-illustrating) of an image-processing method, and two alignment marks 24A and 24B of a cross-joint mold are formed in it at the edge of the direction of X on a substrate 4. And before exposing the master reticle R1 of the 1st sheet, for example, that alignment sensor detects the location of the alignment marks 24A and 24B, and the exposure core of the master reticle Ri can be doubled with the location of the request on a substrate 4 by searching for the physical relationship of the substrate 4 to reference marks 13A and 13B based on this detection result. In addition, without using the alignment marks 24A and 24B to a substrate 4, since it is [that much more exposure is only performed and], alignment of the initial state of a substrate 4 is performed, for example on the appearance criteria of a substrate 4, and it is good to even position a substrate 4 based on the measurement value of a laser interferometer 8 after that.

[0035] Thus, by performing alignment, as shown in drawing 4 , the contraction image PIi by the projection optics 3 of the parent pattern Pi of the i-th master reticle Ri is exposed by the i-th shot field Si in the pattern space 25 of the rectangle surrounded in the side parallel to the X-axis and the Y-axis on a substrate 4. In drawing 4 , the contraction image of the parent pattern already exposed within the pattern space 25 of a substrate 4 is shown by the continuous line, and the unexposed contraction image is shown by the dotted line. Thus, it means that the contraction image of each parent patterns P1-PN was exposed by exposing the contraction image of the parent patterns P1-PN of the master reticles R1-RN of N individual of drawing 1 to the shot fields S1-SN to which it corresponds on a substrate 4 one by one, performing the contraction image and screen splice of a parent pattern which adjoin, respectively. the projection image which reduced the parent pattern 36 of drawing 1 by 1 / alpha twice on the substrate 4 is exposed by this.

[0036] Then, as shown in drawing 2 (E), when the photoresist layer 33 on a substrate 4 is developed and the photoresist is a positive type, the umbra of a projection image is left behind as resist pattern 33a. Next, as shown in drawing 2 (F), after etching the absorption layer 32 by using the resist pattern 33a as a mask, as shown in drawing 2 (G), by exfoliating resist pattern 33a which remains, absorption layer 32a is left behind to the field corresponding to the umbra of the contraction image of a parent mask on the reflective film 31 on a substrate 4, and the working reticle 34 of this example is completed.

[0037] in addition, in case the parent pattern of the master reticle Ri is connected on a substrate 4 as mentioned above and a contraction imprint is carried out The contraction imprint also of the predetermined mark on each master reticle Ri (for example, alignment marks 21A and 21B) is carried out. In case the contraction image of the parent pattern of an adjoining master reticle is imprinted, the location of the latent image of that mark is detected, and it may be made to amend the imprint location of the contraction image of the parent pattern of that adjoining master reticle from this detection result.

[0038] Moreover, when for example, the high density pattern and the isolated pattern are formed in the original edition pattern 27 of drawing 1 , only a high density pattern may be formed in the master reticle Ra of one sheet in the master reticle R1 - RN, and only an isolated pattern may be formed in

another master reticle Rb of one sheet. Since exposure conditions, such as best lighting conditions, image formation conditions, etc., differ by the high density pattern and the isolated pattern at this time, you may make it optimize exposure conditions, i.e., the configuration of the aperture diaphragm in the illumination-light study system 1 and magnitude, a coherence factor (sigma value), the numerical aperture of projection optics 3, etc. according to that parent pattern Pi for every exposure of the master reticle Ri. Moreover, it may especially insert [light filter / (the so-called pupil filter) / predetermined] near the pupil surface of projection optics 3, or in order to optimize the exposure condition, in case an isolated pattern is exposed, the so-called progressive focal method (FREX law) which vibrates relatively [Z direction] the image surface of projection optics 3 and the front face of a substrate 4 by predetermined within the limits may be used together.
[0039] In addition, in the gestalt of the above-mentioned operation, it was not fixed to 16 sheets and the number of sheets of the master reticles P1-PN of drawing 1 is fluctuated with the magnitude of the original edition pattern formed in the working reticle 34 of the reflective mold which it is going to manufacture etc. Moreover, if the original edition pattern is a regular pattern like DRAM, two or more reticles predetermined [of the master reticles P1-PN] can be made to serve a double purpose by the reticle of one sheet. In this case, since the number of sheets of the master reticle which draws with an electron beam exposure system becomes fewer, the time amount which production of a master reticle takes can be shortened.
[0040] Moreover, with the gestalt of the above-mentioned operation, although the silicon wafer is used as a substrate 4 of the working reticle 34, by this, the projection aligner for semi-conductor manufacture shown in drawing 3 can be used almost as it is, and the pattern image of a master reticle can be exposed. Furthermore, since the processors for the conventional silicon wafers (a thin film deposition system, resist coater, a resist developer, etching system, etc.) can use it as it is also as process processors, such as etching, it is not necessary to newly prepare a manufacturing facility, and the manufacturing cost of the working reticle 34 of a reflective mold can be made low. furthermore, the reticle same only by the rest repeating the exposure using an optical projection aligner once it produces the master reticles P1-PN of N sheets of drawing 1 as the working reticle 34 -- required number of sheets -- a short time -- and since it can manufacture in the same precision, while being able to shorten the time amount which manufacture takes as a whole, the whole manufacturing cost can be reduced.
[0041] Next, it explains per example of actuation in the case of exposing using the working reticle 34 of the reflective mold of drawing 1 manufactured as mentioned above. Drawing 5 shows the aligner (henceforth "the aligner for EUVL") of step - and - scanning method (scan exposure mold) with the contraction projection mold which equips with that working reticle 34 and is exposed by using EUV light as an exposure beam, takes the Z-axis in the direction of a vertical in this drawing 5 by taking a Y-axis for the X-axis in parallel with the space of drawing 5 at right angles to the space of drawing 5 in a horizontal plane, and explains. at this time, a reticle stage 41 installs free [migration in the direction of Y] on the reticle base 42 -- having -- the base of a reticle stage 41 -- the substrate holder 22 -- electromagnetism -- it is held by adsorption etc. and the working reticle 34 is held by electrostatic adsorption on the top face (vertical lower part) of the substrate holder 22. The working reticle 34 and the substrate holder 22 are conveyed in one from the projection aligner of drawing 3 .
[0042] And it is reflected by the mirror 51 within projection optics 46, and soft-X-ray IL1 with a wavelength [as an exposure beam] of 13nm injected, for example from the X line sources 43, such as a SOR (Synchrotron Orbital Radiation) ring or the laser plasma light source, illuminates aslant the lighting field of the shape of radii of the pattern space of the working reticle 34 to the direction of a normal. And soft-X-ray IL1 reflected by the working reticle 34 forms the image which reduced the pattern of that lighting field to 1/beta (1/beta is 1/4 at this example) on the wafer (wafer) W for exposure through the 1st concave mirror 52, a convex mirror 53, a plane mirror 54, and the 2nd concave mirror 55 within projection optics 46. Opening is formed in the part which soft-X-ray IL1 passes in concave mirror 52 grade. In order that there may be no suitable penetrable ** material to the EUV light whose wavelength like soft X ray is about 1-50nm, the projection optics 46 of this example consists of reflective systems, and the working reticle 34 of a reflective mold is used also as a reticle.
[0043] Moreover, the numerical aperture of projection optics 46 is 0.08 or more, for example, is set

about to 0.1 to 0.2. Since the wavelength of soft-X-ray IL1 is 13nm, the resolution of about 100-50nm can be obtained according to projection optics 46. Moreover, although the minimum line width of the pattern of the working reticle 34 is set to 400-200nm to obtain the resolution (minimum line width) of 100-50nm, for example, if it is this line breadth, the optical projection aligner of drawing 3 can fully attain.
[0044] Moreover, Wafer W is held on the wafer stage 49 through a non-illustrated wafer holder, and the wafer stage 49 performs step migration of Wafer W in the direction of X, and the direction of Y while carrying out continuation migration of the wafer W in the direction of Y on a surface plate 50. Furthermore, the wafer stage 49 also performs control of the focal location of Wafer W, or a tilt angle so that the front face of Wafer W may be doubled with the image surface of projection optics 46 by the automatic focus method. The location of a reticle stage 41 and the wafer stage 49 is measured by the laser interferometer in the reticle stage drive system 44 and the wafer stage drive system 47, respectively, and the main control system 45 carries out the synchronous drive of a reticle stage 41 and the wafer stage 49 through the reticle stage drive system 44 and the wafer stage drive system 47 based on these measurement values.
[0045] Namely, after carrying out step migration of the one shot field on Wafer W in a run-up starting position at the time of exposure, It synchronizes with scanning the working reticle 34 at a rate VR in the direction (or the direction of -Y) of +Y to the lighting field of soft-X-ray IL1 through a reticle stage 41. The contraction image of the working reticle 34 is exposed by the shot field concerned by scanning Wafer W by rate VR/beta in the direction (or the direction of +Y) of -Y through the wafer stage 49.
[0046] In this case, although the optical axis AX1 of the projection optics 46 of this example is parallel to the direction of a vertical (Z direction) and projection optics 46 is a tele cent rucksack at Wafer W side, tele cent rucksack nature has collapsed in the reticle side. Therefore, when irregularity has arisen on the front face of the working reticle 34 or the front face may hang down to a Z direction, a possibility that distortion etc. may arise is in the contraction image on Wafer W. However, in this example, the working reticle 34 is conveyed in one with the substrate holder 22, and while there is no possibility that a foreign matter etc. may be inserted into the rear face of the working reticle 34, since the working reticle 34 is adsorbed mostly on the whole surface, the pattern side of the working reticle 34 is maintaining very high flatness (it is about 0.1-0.3 micrometers or less at 100mm angle). Therefore, the contraction image of the pattern of the working reticle 34 is always imprinted with high precision on Wafer W.
[0047] In addition, of course, configurations various in the range which this invention is not limited to the gestalt of above-mentioned operation, and does not deviate from the summary of this invention can be taken.
[0048]
[Effect of the Invention] According to the manufacture approach of the mask of this invention, on the 2nd substrate, since the drawing error of the 1st original edition pattern can manufacture even any number of masks same only by imprinting the pattern of a parent mask on the 2nd substrate with an optical projection aligner while being reduced, it has the advantage which can form the mask in a short time with high precision.
[0049] Moreover, since the mask has the reflecting layer which reflects extreme ultraviolet radiation, in the aligner which uses extreme ultraviolet radiation as an exposure beam, the mask can be used for it as a mask of a reflective mold. Moreover, since the optical projection aligner for example, for semi-conductor manufacture can be used as it is when the substrate is a circular substrate like a semi-conductor wafer, there is an advantage which can reduce the manufacturing cost of the reflective type of mask.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] In an example of the gestalt of operation of this invention, it is drawing showing the production process for [whole] exposing the contraction image of a master reticle and manufacturing a working reticle.
[Drawing 2] It is the enlarged drawing which cut and lacked the part which shows each production process for applying a photoresist to the substrate for the working reticles, and forming an original edition pattern.
[Drawing 3] It is the block diagram showing the optical projection aligner used in case contraction projection of a master reticle is performed with an example of the gestalt of the operation.
[Drawing 4] In the projection aligner of drawing 3 , it is the perspective view of an important section showing the condition of projecting the contraction image of the parent pattern on a master reticle on a substrate 4.
[Drawing 5] It is the block diagram which expressed the part which shows an example of the aligner which equips with the working reticle manufactured with the gestalt of the operation, and is exposed, using EUV light as an exposure beam in the cross section.
[Description of Notations]
R1 - RN-- master reticle (parent mask), and P1 - PN -- the divided parent pattern and 3 -- the substrate for projection optics and 4 -- working reticles, 5 -- sample base, and 6 -- an X-Y stage, 16 -- reticle library, 18 -- slide equipment, and 19 -- a reticle loader, 22 -- substrate holder, 27 -- original edition patterns, and 31 -- the reflective film, 32 -- absorption layer, 33 -- photoresist layer, and 34 -- a working reticle, a 43 --X line source, and 46 -- projection optics

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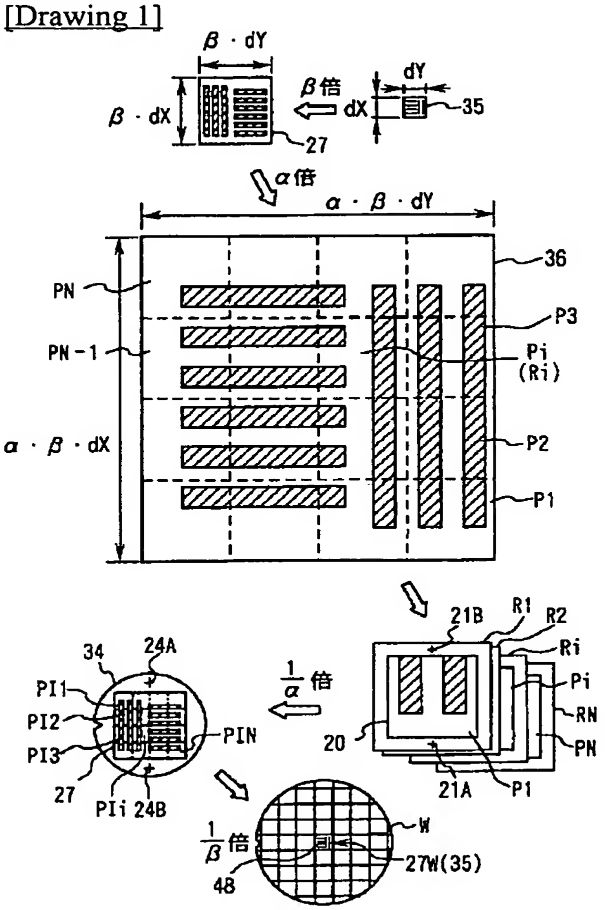
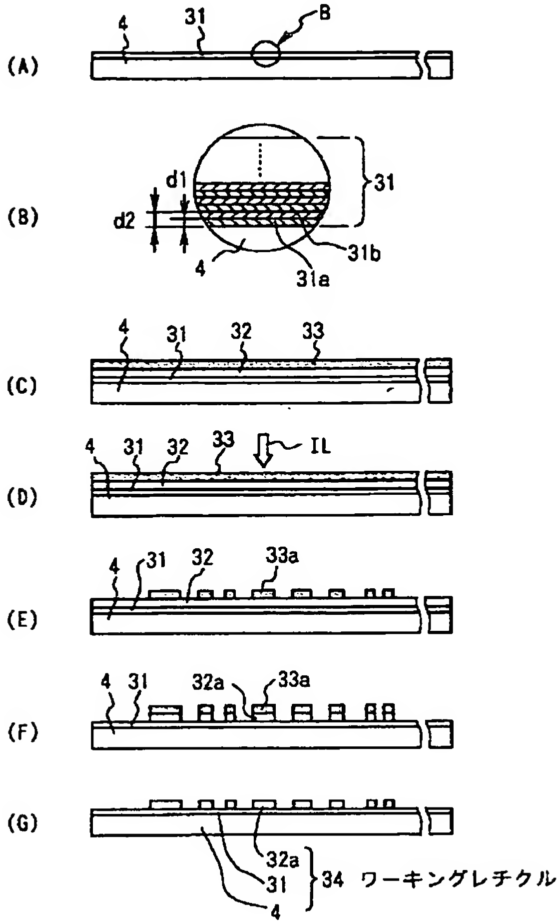
[Translation done.]

DRAWINGS

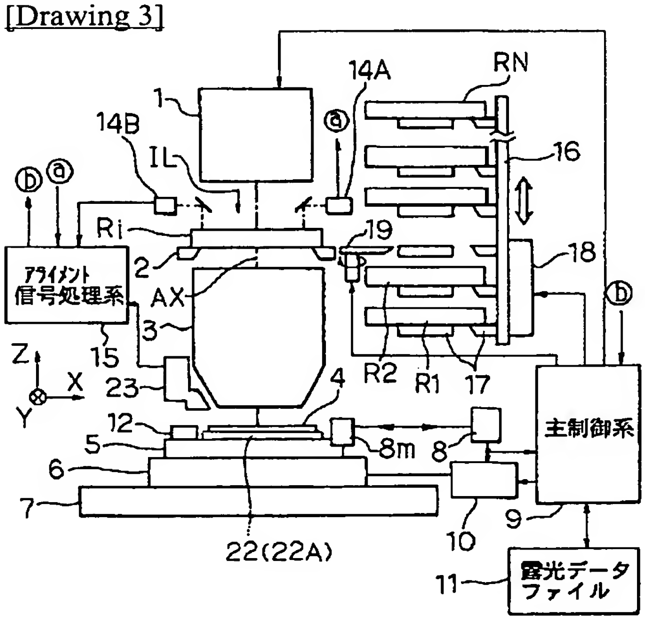
[Drawing 1]



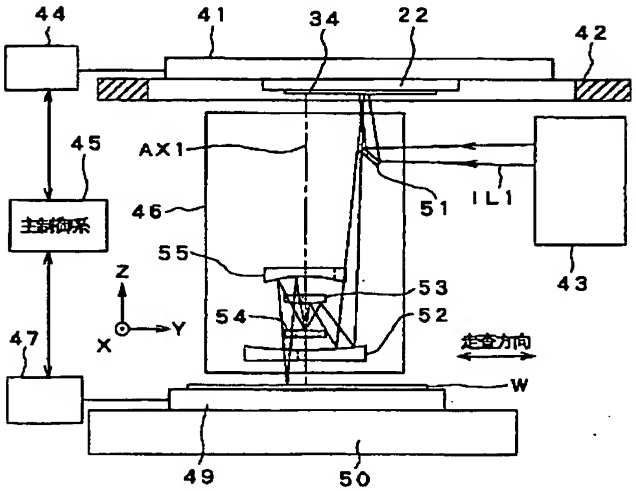
[Drawing 2]



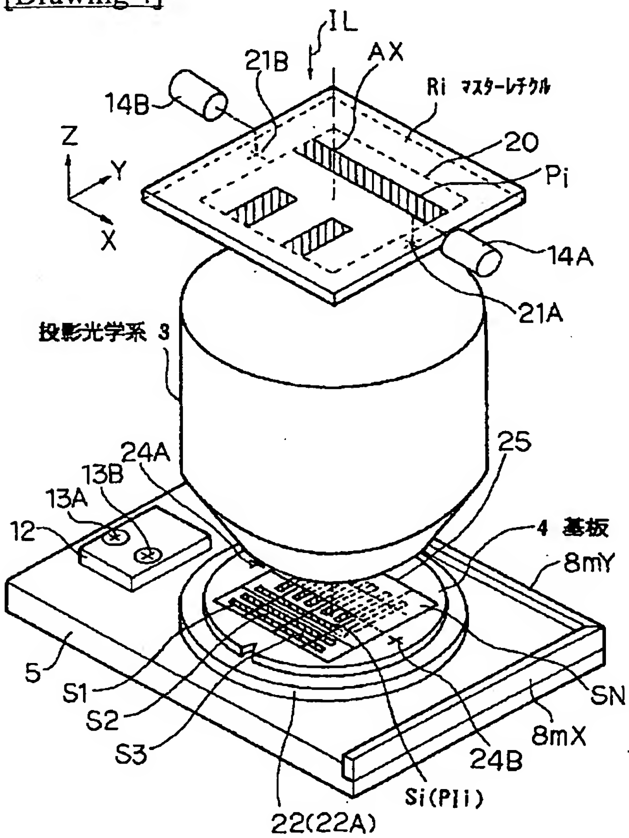
[Drawing 3]



[Drawing 5]



[Drawing 4]



[Translation done.]